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Research Article

Effect of moderate - vigorous intensity physical exercise on female sex hormones in premenopausal university students in Nnewi, Nigeria

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ABSTRACT

Background: Sedentary lifestyle and diseases associated with it is on the increase in our communities, state and country as a whole. The objective was to determine the effect of exercise on ovarian reserve status of the participants using day 3 FSH, LH and estrogen values and the ovulatory status of the participants using day 21 progesterone values.
Methods: The study was a prospective comparative study. A total of 30 participants were recruited for this work. They were divided into 2 groups: 15 subjects that did exercise for 1 month and 15 controls that didn't do any form of exercise. Baseline blood samples were collected from the two groups on day 3 and day 21 of the menstrual cycle. The subjects started exercise on day 1 of the next menstrual cycle. Blood samples were collected from the subjects and control on day 3 and day 21 of the next menstrual cycle.
Results: There was significant reduction in weight and therefore BMI of the study group compared to control group and study group baseline after one month of exercise ($P<0.05$). There were no significant differences in the baseline levels of Estrogen, FSH, LH and progesterone between the subjects and control groups before the exercise, but after 1 month of exercise, there were significant differences in the levels of estrogen, FSH, LH and progesterone in these groups ($P<0.01$). Among the study group there were significant differences in the baseline and final levels of Estrogen, FSH, LH and Progesterone ($P<0.01$).
Conclusions: The hormonal pattern shows that moderate-vigorous exercise may increase the responsiveness and sensitivity of the follicles to FSH and LH with attendant increase in ovulatory status of young females.

Keywords: Exercise, Female sex hormones, Premenopausal

INTRODUCTION

Physical exercise is a subcategory of Leisure-time physical activity (LTPA) that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective.[1] It is defined as any bodily movement produced by contraction of skeletal muscles that substantially increases energy expenditure.[1] It is associated with lower risk of several diseases including: Cardiovascular disease,[2] Breast cancer,[3] Obesity,[4] Type 2 diabetes mellitus,[5] Osteoporosis, Protect ovarian function,[6] It affects hormonal milieu, including sex steroid hormones and metabolic profiles.[7]

However, hormones are specific regulatory molecules that modulate reproduction, growth, development and the maintenance of internal environments as well as energy production, utilization and storage.[8] Physical exercise specifically causes suppression of hypothalamic pulsatile release of GnRH, which normally occurs every 60–90 min, limits pituitary secretion of luteinizing hormone (LH) and, to a lesser extent, follicle-stimulating hormone (FSH), which, in turn, limits ovarian stimulation and estradiol production.[9] The suppression of reproductive function in women engaged in sports emphasizing leanness may be a neuroendocrine adaptation to caloric deficit,[10] however the energy drain theory is inadequate to explain the reproductive dysfunction of women in all athletic disciplines. Sports which emphasize strength over leanness, such as swimming and rowing, are not associated with low weight and restrictive eating patterns,[11] yet athletes engaged in these sports are vulnerable to menstrual irregularities as well. The endocrine profile of athletes engaged in these sports is characterized by mildly elevated LH levels, elevated LH/FSH ratios and mild hyperandrogenism rather than the hypoestrogenism observed in athletes engaged in sports requiring thinness.[12]

Activation of the hypothalamic–pituitary–adrenal axis may occur in this syndrome, resulting in increased levels of androgens, in particular dehydroepiandrosterone sulfate (DHEA-S). Chronically high concentrations of DHEA-S, or the repeated acute elevations of DHEA-S which have been shown to occur in swimmers,[13] may impair follicular development and result in the anovulation or amenorrhea observed in these women.

METHODS

Participants were recruited through a random selection out of the female students in College of Health Sciences, Nnamdi Azikiwe University (N.A.U). They received a letter explaining the goal of the study and a short eligibility questionnaire. They completed and signed an informed consent form. They were randomly divided into two groups with 15 females in each group. Group 1 (study group) was made up of 15 females who did moderate -vigorous exercise with cycle ergometer for 30 minutes each day, 5 times a week while group 2 (Control group) was made up of 15 females who did not do any form of exercise.

Exercise was done with a YMCA Sub-Maximal Bicycle Test protocol.[14] Group exercise took place in Medical Rehabilitation Gymnasium Okofia. The training continued with moderate-to-vigorous level of aerobic exercise on 59 – 85% of the age-predicted maximum heart rate. The maximum heart rate is established as 220 minus the person's age in years.[15] The participants received heart rate monitors to control their training intensity.[15] Additionally, a resistance level that suits the subject was chosen.

Specimen Collection

4ml of venous blood was collected on days 3 and 21 of the menstrual cycle, before and after one month exercise. The sample was dispensed into a plain bottle and allowed to clot, retract and centrifuged at 3000rpm for 10 minutes. Serum stored at -20°C until analysis. Enzyme immunoassay test kit (BioCheck, USA) was used for the quantitative determination of FSH, LH, Progesterone, and estrogen in human serum. The manufacturer's instructions were followed strictly while carrying out the analysis. The data from study and control groups were coded, computed and the paired t-test and independent t-test were done using SPSS version 20 (IBM, USA). P value of <.05 was considered significant.

RESULTS

The mean age of volunteers in study group and control group were 21.20±1.7 and 21.33±1.68 years respectively. There was no significant difference in the ages of the study and control groups (P =.830) but there were reduction in the body weight and BMI of the study group compared to baseline of the study group and control group (Table 1). Serum levels of day 3 Estrogen, FSH and LH of the study group showed significant reduction compared to control group and the serum levels of day 21 progesterone of the study group significantly increased compared to control group (Table 2).

Table 1: Anthropometric measurements in the study group (n=15) and control (n=15) group.

Parameter	Group			P-value
		Study (X±SD)	Control (X±SD)	
Age (Year)		21.20±1.7	21.33±1.68	.830
Height (cm)		165.9±3.71	165.1±3.72	.560
Weight (kg)	Baseline	63.53±2.39	62.27±3.75	.279
	After one month	54.47±3.14	62.8±3.36	.000*
BMI (kg/m^2)	Baseline	23.27±0.89	22.84±1.31	.295
	After one month	19.79±1.18	23.04±1.25	.000*

Significant values set at P < 0.05.

*- Significant

Table 3 showed that after one month of exercise, serum levels of day 3 Estrogen, FSH LH of the study group showed significant reduction compared to their baseline however, there was significant increase in progesterone level of the subjects after one month of exercise (P value ≤0.001).

Table 2: Serum Estrogen, FSH, LH and Progesterone Levels in Study and Control groups (Mean±SD).

Parameters	Day of menstrual cycle	Group(n=30)			P-value
			Study (X±SD)	Control (X±SD)	
Estrogen (pg/ml)	3	Baseline	35.27± 5.8	35.70± 5.31	.833
		After one month	19.53± 6.7	35.4± 5.28	<.001 *
FSH (mIU/ml)	3	Baseline	8.47± 5.50	10.51± 4.61	.282
		After one month	6.07± 4.06	10.46± 4.50	<.009 *
LH (mIU/ml)	3	Baseline	12.31± 3.87	11.07± 3.8	.383
		After one month	9.45± 3.94	12.65± 2.37	.012*
Progesterone (ng/ml)	21	Baseline	3.40± 3.01	3.63± 3.16	.842
		After one month	8.42± 2.56	3.64± 3.09	<.001 *

Significant values set at P < 0.05.

*- Significant

Table 3: Serum Estrogen, FSH, LH, and Progesterone levels in study group.

Parameters	Day of menstrual cycle	Group (n=15)		P value
		Before Exercise (X±SD)	After Exercise (X±SD)	
Estrogen (pg/ml)	3	35.27±5.8	19.53±6.7	<.001*
FSH (mIU/ml)	3	8.47±5.50	6.07±4.06	<.001*
LH (mIU/ml)	3	12.31±3.87	9.45±3.94	<.001*
Progesterone (ng/ml)	21	3.40±3.01	8.42±2.56	<.001*

Significant values set at P < 0.05.

*- Significant

DISCUSSION

This study evaluated the effect of one month moderate – vigorous intensity physical exercise on the ovarian reserve status of the participants using day 3 FSH, LH and Estrogen levels, the ovulatory status of the participants using day 21 progesterone. There were reduction in the body weight and BMI of the study group compared to baseline of the study group and control group. This is in line with the work of Maiya et al 2008 who reported significant decrease in body mass Index and weight respectively of the study group compared with control group after physical exercise, though duration of exercise of his work was 3 months.[16]

Regular exercise can markedly reduce body weight and fat mass without dietary caloric restriction in overweight individuals. A minimum of 60 min, but most likely 80–90 min of moderate-intensity physical activity per day maybe needed to avoid or limit weight regain and to prevent and treat cardiovascular diseases in formerly overweight or obese individuals.[17] King et.al also reported reduction in weight in men and women after 12 weeks supervised aerobic exercise intervention.[18] Weight loss is typically this small primarily because obese people often have difficulty performing sufficient exercise to create a large energy deficit, and it is relatively easy to counterbalance increased energy expenditure through exercise by eating more or becoming less active outside of exercise sessions.[19] The alterations in body composition most often attributed to aerobic exercise are a decrease in fat weight and a maintenance or slight increase in fat-free mass indicating the importance of aerobic exercise to burning calories and losing body fat.

The Comparison of the hormonal profile of the study group: the baseline and one month after exercise, and with the control group, showed reduction in day three estrogen. This study found stronger effects of exercise on endogenous estrogen levels than the other published exercise trials. According to McTiernan et.al, a statistically significant reduction of estrogen levels as a result of exercise was observed at 3 months,[20] but this study showed statistical significant reduction of estrogen levels only after one month of exercise. Also Christine et.al reported that exercisers who adhered to 150 to 225 min/wk had an 18% reduction in estradiol concentrations compared with controls and a trend of percent change in estradiol levels with increasing exercise adherence was also observed.[21] Exercise and participation in sports, even if only of moderate intensity are associated with reduced levels of ovarian Estrogen.[22] A study showed that moderate levels of leisure-time physical activity enhance estrogen metabolism, especially among women with higher body weight.[2]

Physical activity may influence circulating estrogens by reducing adiposity, which decreases conversion of androgens to estrogens by aromatase or may have effects independent of a change in adiposity, including a reduction in insulin levels, which, in turn, increases SHBG levels and decreases estradiol bioavailability.[24] The suppressive effect of sports participation and exercise may explain the findings of epidemiological studies showing that women with higher levels of recreational activity have a lower risk of breast cancer. Some trials found no significant effects of exercise on estrogen levels.[25,26,27]

Moreso, this present study observed a significant reduction in the gonadotropins (Follicle stimulating hormone and luteinizing hormone) of the study group compared with the baseline of the study group and the control. This is in agreement with Loucks *et. al.*, who said that physical activity limits pituitary secretion of

luteinizing hormone (LH) and, to a lesser extent, follicle-stimulating hormone (FSH), which, in turn, limits ovarian stimulation and estradiol production. He also observed in his another work that exercise alone has no effect on LH pulsatility[28] which is not in agreement with the result of this study because the participants didn't have caloric restriction yet there was reduction in LH after exercise. Too much exercise can have negative effects on the reproductive system, including primary and secondary amenorrhea probably through luteinizing hormone (LH) and follicle stimulating hormone (FSH) suppression by involving the hypothalamo-pituitary-gonadal axis.[10]

Also the result of this study showed significant increase in day 21 Progesterone. According to Bhattacharya, 2005 any level of progesterone more than 3 ng/mL confirms ovulation. Results from the Nurse's Health Study indicate reduced risk of ovulatory infertility in women doing vigorous exercise for at least 30 min daily.[29] Also a report of a cohort study indicated a 7% relative risk reduction for ovulatory infertility for each additional hour of vigorous exercise per week.[30] Exercise-induced weight loss has been shown to improve metabolic function and hormonal profiles, and often leads to significant increase in fertility.[31]

CONCLUSION

Moderate-vigorous exercise causes some changes in the reproductive hormone levels in females with significant decrease in day 3 estrogen, LH, FSH and significant increase in day 21 progesterone hormone levels. The hormonal pattern shows that moderate-vigorous exercise may increase the responsiveness and sensitivity of the follicle to FSH and LH with attendant increase in ovulatory status in young females.

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